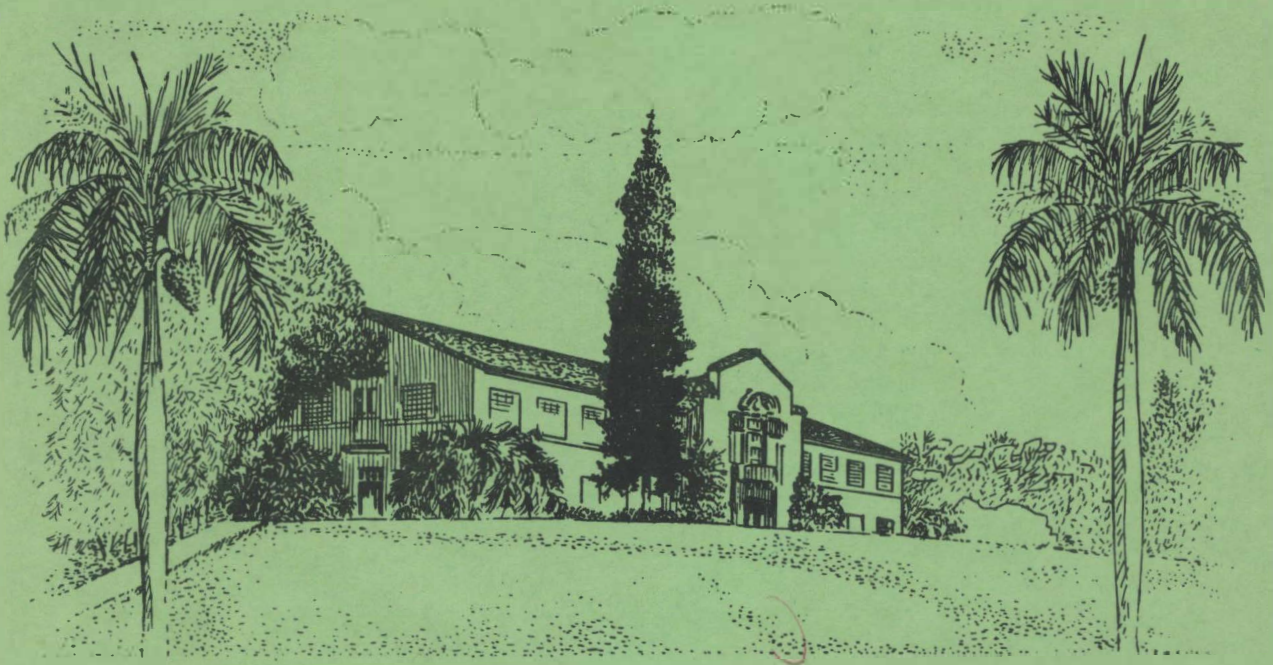


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INSTITUTE OF TROPICAL FORESTRY
RIO PIEDRAS , PUERTO RICO

FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

CENTRAL FILE COPY

ANNUAL REPORT FOR 1963

INSTITUTE OF TROPICAL FORESTRY

The forest problems of Puerto Rico and the Virgin Islands, problems common to many tropical areas, those of deficient forests, both in area and in productivity, and of incomplete utilization of available forest products, were the subject of an intensified program of research, demonstration, and technical assistance at the Institute of Tropical Forestry in 1963. The attack on these problems has not changed in its general character: (1) the search for forest crops attractive economically to the owners of most of the lands which are or should be dedicated to forestry, (2) the development of less expensive techniques for establishing and maintaining at full productivity such crops, (3) the discovery of new uses for tree products, (4) the development of practical techniques for processing these products for their utilization to greatest advantage, and (5) the dissemination of useful information regarding the findings from these efforts. The intensification was manifest in more personnel, more facilities, more investigations, more publications, and expanded cooperative, demonstration, and technical assistance activities.

Evidence of forestry progress during 1963 in Puerto Rico and the Virgin Islands is apparent in a variety of developments. High survival and rapid growth of recent plantations has increased interest in reforestation by both public and private landowners. The demand for planting stock for reforestation of private lands was never greater. Cooperative Forest Management program was expanded to provide farm forestry technical assistance to 65 percent of Puerto Rico. Site adaptability studies with Honduras pine throughout Puerto Rico continue to provide encouragement for further expansion in the production of planting stock of this species. Development of a simple machine for filling polyethylene bags has made more practical such production. Long-range, low-interest credit was offered by the Federal Government forest plantations for the first time. Feasibility studies of the Puerto Rico Industrial Development Company showed commercial treatment of fence posts with preservatives to be a promising forest products industry, and thus one eligible for a number of financial incentives. As a beginning the Agricultural Conservation Program has agreed to offer premium cost-sharing payments to landowners who use properly treated posts. The Commonwealth Government acquired a portable sawmill to pioneer utilization of thinnings and other small sawtimber from its public forests. Recreation areas on public forest lands have been improved and expanded. In the Virgin Islands the Government has undertaken the production of tree planting stock on St. Croix for use on both public and private lands.

The activities of the Institute were reorganized during 1963 into three broad projects: (1) research in tropical silviculture; (2) forest products utilization, including both research and technical assistance; and (3) applied tropical forestry, including the development and administration of multiple use in the Luquillo Experimental Forest, technical forestry assistance on state and private forestry lands, and the training of students in tropical forestry. The 1963 training activities were carried out largely before this reorganization, directed by the personnel in Tropical Silviculture.

About 35 percent of the financial resources for the operation of the Institute were dedicated to tropical silviculture. The study of the adaptability of a number of tree species to extensive sites continued to make up the core of the program in this field. Analysis of the climate of the Luquillo Mountains was advanced substantially and will be completed next year. More than 300,000 cards with hourly data from nine field stations are involved. Intensification of research on tree quality in mahogany has been planned in detail. The first study will involve the collection of seed from some 60 provenances of mahogany in the West Indies, Mexico, Central America, and northern South America.

Forest products utilization research and technical assistance accounted for about 15 percent of the financial resources of the Institute. Continued observations on service tests of fence posts treated with preservatives are providing more reliable estimates of the benefits of such treatment under local conditions. The efficacy of using an inexpensive solar drier for mahogany lumber was determined. Studies of the machinability of mahogany lumber from a variety of sources were continued during the year and are expected to be completed next year. A commercial plant for treating fence posts was promoted and is to be in operation next year.

About 45 percent of the funds available to the Institute were dedicated to the Applied Tropical Forestry project. Timber management was intensified in the Luquillo Experimental Forest. The promising components of the forest were inventoried, two compartments were artificially regenerated, and more than half of the best stands were subjected to their second scheduled liberation cutting. Recreation use of the forest by the general public continued its recent increase at the annual rate of about 10 percent.

Technical assistance to the owners of private forest lands was expanded in both Puerto Rico and the Virgin Islands as a result of increased contributions to these programs by the Institute's cosponsors of the work, the governments of Puerto Rico and of the Virgin Islands. This expansion was in the form of production of planting stock and in field personnel.

The 1963 tropical forestry short course was one of the largest to date, with 23 participants. In addition the second graduate-level summer session on tropical forestry of the New York State College of Forestry at Syracuse University was held at the Institute.

Facilities

The basic facilities of the Institute, its headquarters buildings, laboratories, library, and experimental forests, all were improved materially during the year. Financial support for much of this improvement came from allotments aggregating \$301,000 from the Accelerated Public Works Program. With these funds the following major physical improvements were contracted or completed: new air-conditioned laboratory space in the basement of the headquarters building, a potting room, warehouse, and shade house, dry house and hydroponics beds for the experimental nursery, a reconstructed wood laboratory and shop building, a new room for training, better access and parking facilities at headquarters, new portal signs for the Luquillo Forest, a garage-warehouse at the Sabana Ranger Station, a visitors information center building and a new picnic area within the La Mina Recreational Area, and reconstruction of the foot trail to El Toro Peak. Acquisition of the 147-acre area in St. Croix, designated the Estate Thomas Experimental Forest, was completed. The area is almost completely forested with nearly pure stands of mahogany and plantations of teak.

The wood laboratory facilities were expanded by the acquisition of an experimental multiple-spindle carving machine, believed to provide a basis for complete utilization of unusual local woods available only in small size or quantities.

Personnel

The working force of the Institute during 1963 was 132 employees, of which 24 were permanent and full time. One new professional position was added and filled by Juan E. Muñoz after completion of a Master's degree in forestry at North Carolina State University. After about two years' vacancy the position of project leader for forest products utilization was filled by Martin Chudnoff, a man with several years of similar experience in Israel. Joseph W. Sposta, in charge of applied tropical forestry, transferred to the Hiawatha National Forest in Michigan, and was replaced by Lawrence W. Hill, from the Pacific Southwest Forest and Range Experiment Station in California.

The personnel of the Institute took advantage of a variety of training opportunities during the year. These ranged from formal university instruction to brief specialized courses. Subjects included advanced mathematics, statistical analysis, programming of computing machines, genetics, cooperative forestry, contracting, personnel management, accounting and payrolling, administrative management, first aid, and accident prevention. In the 201,000 man-hours of work performed during the year there were 14 disabling injuries. One vehicle accident occurred in 163,000 miles of driving.

External Relations

The Institute continues to depend heavily, for its progress and effectiveness, upon the cooperation received from a large number of

other agencies. The most outstanding examples of such cooperation during 1963 are reported here.

The Agricultural Experiment Station of the University of Puerto Rico, upon whose grounds the Institute headquarters is located, shared the main building and the costs of its maintenance. The Station provided technical counsel in a variety of related basic fields of research, conducted cooperatively leaf analyses upon which a study of teak fertilization rests, and generously made available a large amount of time on electronic data processing machines.

The Division of Forests of the Bureau of Conservation of the Puerto Rico Department of Agriculture continues to make available for the research of the Institute its 60,000 acres of forest lands representing most of the sites of Puerto Rico. New studies of site adaptability of tree species and the retention of preservatives in fence posts were undertaken cooperatively by the Division during the past year. The Division contributed in 1963 about \$80,000 to programs of tree production and distribution and farm forestry technical assistance which are shared by the Institute.

The Virgin Islands Agricultural Experiment Station has generously provided office, vehicle storage, and nursery space for the Virgin Islands Forestry Program of the Institute. Technical counsel and the processing of temporary personnel were added benefits received from this agency.

The Virgin Islands Corporation, which for many years financed the entire Virgin Islands Forestry Program, has continued to underwrite the operation of the sawmill and preservative treating plant used in the Program. During 1963 the Corporation transferred the Estate Thomas Experimental Forest to the Institute at a very reasonable book value.

The Government of the Virgin Islands in 1963 took over financial responsibility for the production of planting stock for farm forestry. The Government has continued its support of the roadside tree improvement program conducted under the technical supervision of the Institute.

The Agency for International Development has provided full financial support for the training of those students and foreign visitors who come to the Institute under AID auspices. Included has been funds for the more important training facilities and materials needed.

The Commonwealth Government has continued very substantial cooperation in the development and maintenance of the Luquillo Forest. The Department of Public Works maintains all public roads within the area and is sharing the costs of construction of a new road. The Administration of Public Parks and Recreation maintains most of the federally constructed facilities within the La Mina Recreational Area.

The Quartermaster Research and Engineering Command of the Department of the Army continued its support of an analysis of mass climatic data from the Luquillo Mountain area. The Puerto Rico Nuclear Center of the University of Puerto Rico, an entity of the Atomic Energy Commission, is undertaking an intensive study of the effects of gamma radiation on tropical vegetation within the Luquillo Experimental Forest. The Institute is participating in this study, which should produce a large amount of new basic information about the forest environment.



Importance of provenance. Both seedlings shown are Pinus oocarpa. The bushy seedling at the left is from Mexican seed; the single, erect seedling at the right is from Guatemalan seed.

RESEARCH IN TROPICAL SILVICULTURE

The basic aim of silvicultural research is to grow more trees and better trees, per acre and per dollar. Because quality wood is currently the scarcest forest product in Puerto Rico and the Virgin Islands, recent research has been concentrated on adaptability studies, to determine the species—whether native or exotic—and sites best adapted to plantation management for quality products.

Promising species have now been selected for all the major sites, so research effort is shifting to silvicultural practices for increasing the volume and value of the yield for each species. These are, briefly: seed source, nursery practice, spacing, plantation care, site improvement, and thinning. Harvesting and regeneration are not immediate problems.

Dendrology

Page proofs of "Common Trees of Puerto Rico and the Virgin Islands" and the Spanish version, "Arboles Comunes de Puerto Rico e Islas Vírgenes", were received, corrected, and returned to their respective printers.

The Ciénaga Alta Arboretum was expanded by 45 new species, varieties, or provenances, bringing the total to 90. The arboretum was mapped to scale.

In cooperation with the Syracuse University College of Forestry a key based on vegetative characteristics only was prepared for 50 species native to the Luquillo Experimental Forest.

Phenology

Summary of existing weather data for the Luquillo Mountains was essentially completed. Coordinated readings of temperature, rainfall, soil moisture, and tree diameter growth are continuing at one station on the forest.

Variation and Selection

A plan for studying specific and geographic variation in the genus Swietenia was prepared. Seeds and wood will be collected from naturally-occurring trees from approximately 60 locations throughout the natural range of the genus. A provenance archive will be established in the Luquillo Experimental Forest, as well as adaptability studies on

promising sites throughout Puerto Rico and St. Croix. Once established the material will be available to any interested scientist.

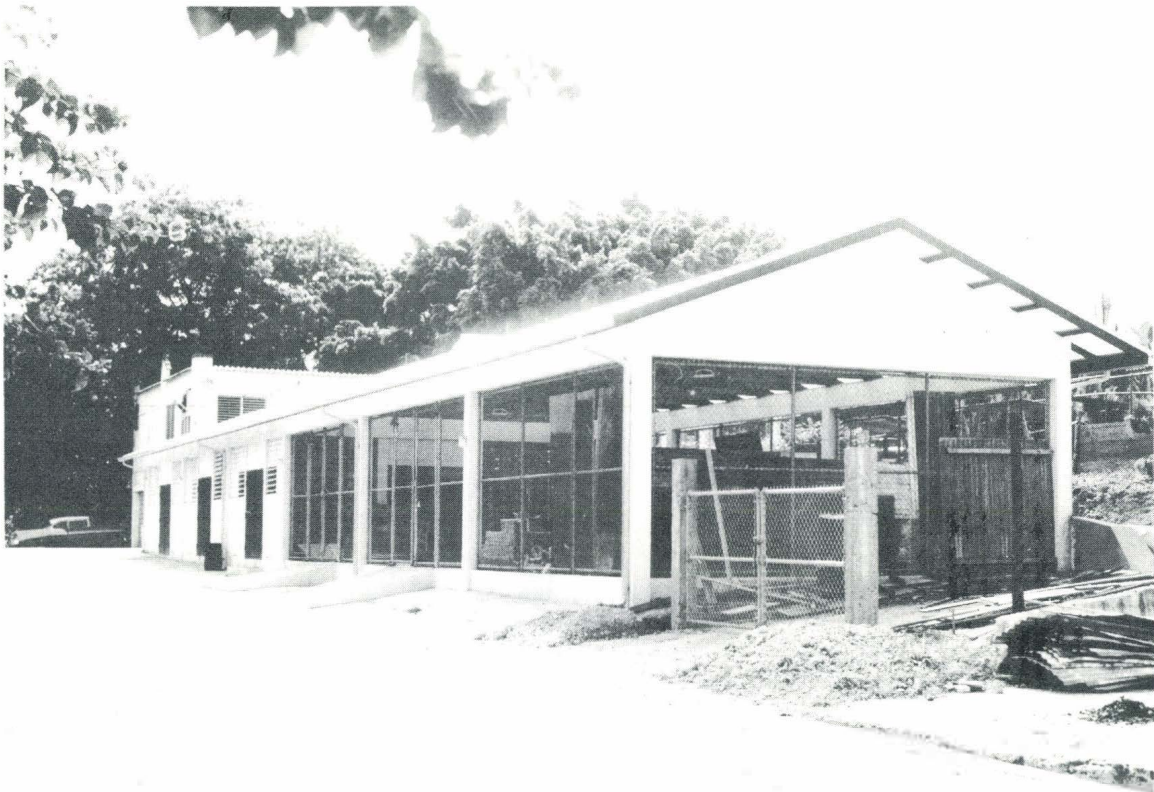
Seedlings of Pinus caribaea Morelet from seed collected in the Bahamas Islands and Honduras were outplanted; seedlings of Cuban and British Honduran origin were outplanted previously, so of the major seed sources for this species we lack representation only from Guatemala.

Site Improvement

Fertilization of plantation teak (Tectona grandis L.F.) was continued. Seedlings of many species were fertilized at outplanting at three new locations. No new analysis of results has been completed, but after three years, teak diameter growth was highly significantly correlated with total NPK applied.

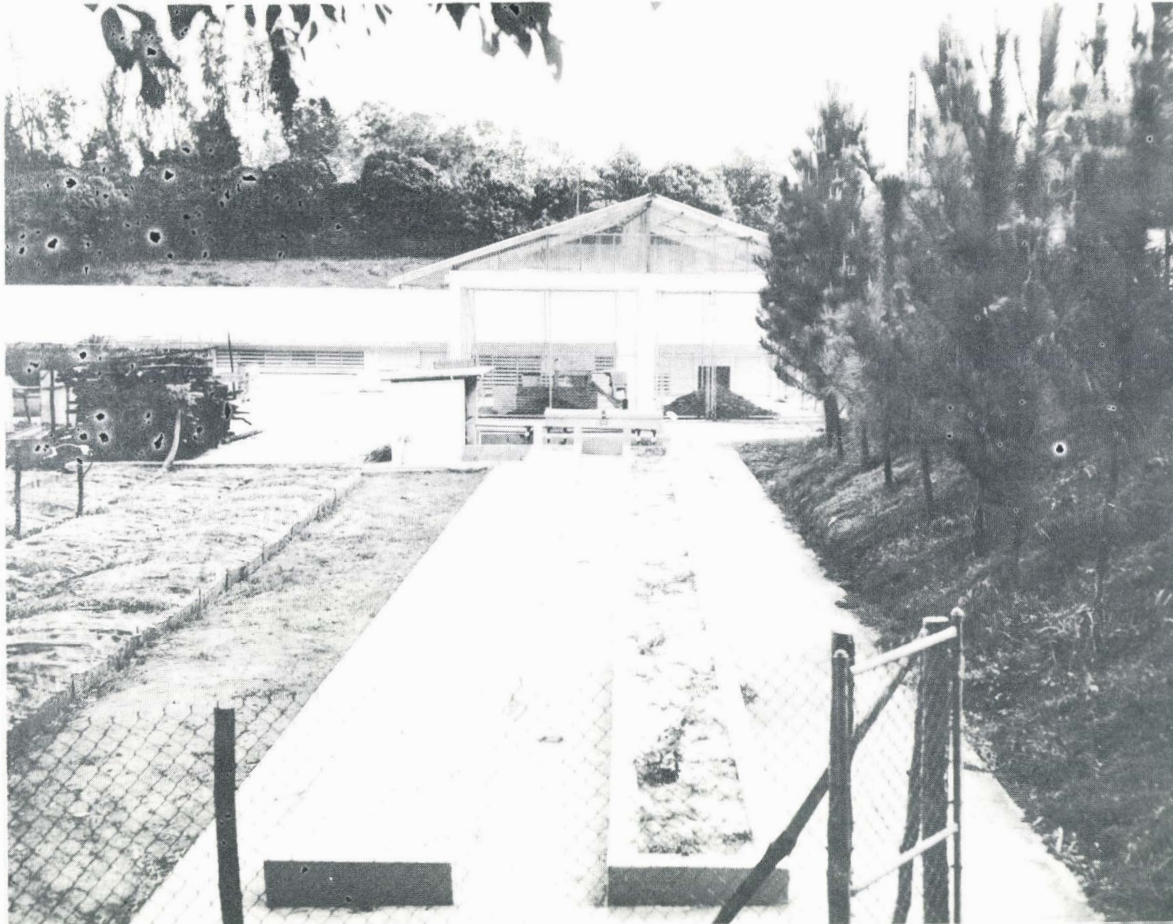
Nursery Practice

A new combination warehouse-headhouse-potting shed-shade house just completed will permit more efficient and more economical production of planting stock.



Potting room, warehouse, and shade house, with translucent Fiberglas roof, for starting transplants. Río Piedras headquarters.

In addition a shade house and laboratory facilities are partially completed for conducting studies of seedling nutrition. Two hydroponics beds, each 60 feet long, will be used for pilot scale tests of the results of the nutrition studies.



Hydroponics beds and dry house, with transparent roof, for studies of seedling nutrition. Río Piedras headquarters.

A machine for filling plastic bags with a potting medium was developed and is now being thoroughly tested. Utilizing only a steel drum, small motor, and an auger with fittings, it is simple and economical. Tests so far indicate three times as many bags can be filled per man-hour with the machine. When tests are completed, construction will be fully described in a separate report.

A study on nutrient irrigation of seedlings (hydroponics) indicated that rooting medium strongly influences the survival and initial growth of Honduras pine seedlings in the hydroponics beds. As noted above, facilities now under construction will allow more intensive as well as more extensive investigations in this field.

Vermiculite with which dry fertilizer had been mixed was used as a potting medium, and seedling development was compared with that under normal nursery practice (fertilization with a solution from overhead, once a month beginning the second month). No benefits were seen and seedlings in the mixture of vermiculite and dry fertilizer appeared to be much more sensitive to the watering regime during the first month. The tests were not exhaustive.

Honduras pine (Pinus caribaea hondurensis Barrett & Golfari) seedlings were found to grow faster as photoperiod was extended from 8 to 16 hours per day. Growth with an interrupted period of 11 hours (8 + 3) exceeded that for 16 hours.

Species Adaptability

Adaptability studies were established at four new locations in Puerto Rico and two in St. Croix, V. I.

A partial summary of the results are shown in Tables 1 - 4, below. These tables must be interpreted with caution. Growth records summarized are cumulative, and do not represent the same stems at the various ages listed. Similarly microsites varied between years. In addition, all microsites are not equally represented in data for one age group. The humid limestone region, especially, varies widely in site productivity, which is confounded with species potential in these tables. For the sandy loam soils an additional 19 species are under test; for the mountain clays, 36; for the humid limestone, 19; and for the serpentine soils, 12.

Table 1.—Mean tree heights on humid limestone soils^{1/}

Species	Years in Field ^{2/}			
	One	Two	Three	Four
	<u>Feet</u>	<u>Feet</u>	<u>Feet</u>	<u>Feet</u>
<u>Pterocarpus indicus</u>	4.3	11.0	17.9	
<u>Anthocephalus cadamba</u>	5.0	15.8	16.7	
<u>Hibiscus elatus</u>	4.0	10.0	15.7	
<u>Enterolobium cyclocarpum</u>	4.1	11.0	12.2	
<u>Pinus caribaea caribaea</u> (Cuba)	2.5	5.8	12.0	
<u>Tectona grandis</u>	1.1	5.2	10.3	
<u>Pinus caribaea hondurensis</u> (British Honduras)	2.0	2.4	9.7	6.8

^{1/} All heights were measured to completed feet.

^{2/} Growth records used are cumulative, therefore means for different age classes are not based on the same individual trees nor on the same microsites.

Table 2.—Mean tree heights on mountain clay soils^{1/}

Species	Years in Field ^{2/}			
	One	Two	Three	Four
	Feet	Feet	Feet	Feet
<u>Schizolobium parahybum</u>	2.7	4.7	16.6	24.7
<u>Eucalyptus kirtoniana</u>	-	7.2	15.6	22.1
<u>Anthocephalus cadamba</u>	1.5	6.8	11.7	17.9
<u>Hibiscus elatus</u>	2.0	5.4	13.7	16.4
<u>Tectona grandis</u>	0.9	2.5	8.9	15.1
<u>Eucalyptus</u> (Bangalore hybrid)	3.8	7.6	12.1	14.0
<u>Enterolobium cyclocarpum</u>	1.5	4.4	6.8	13.2
<u>Casuarina equisetifolia</u>	-	7.3	12.3	12.9
<u>Samanea saman</u>	1.0	1.8	5.2	11.6
<u>Cedrela toona</u>	-	-	17.0	11.0
<u>Pinus caribaea hondurensis</u> (British Honduras)	1.4	2.8	9.1	8.3

^{1/} All heights were measured to completed feet.

^{2/} Growth records used are cumulative, therefore means for different age classes are not based on the same individual trees nor on the same microsites.

Table 3.—Mean tree heights on mountain serpentine soils^{1/}

Species	Years in Field ^{2/}	
	One	Two
	Feet	Feet
<u>Eucalyptus</u> (Bangalore hybrid)	1.7	3.5
<u>Pinus echinata</u>	-	2.6
<u>Hibiscus elatus</u>	1.6	2.4
<u>Taxodium mucronatum</u>	1.2	1.6
<u>Swietenia mahagoni</u>	0.3	1.7
<u>Anthocephalus cadamba</u>	1.0	1.5
<u>Khaya senegalensis</u>	0.3	1.1
<u>Pinus oocarpa</u> (Guatemala)	0.3	1.1

^{1/} All heights were measured to completed feet.

^{2/} Growth records used are cumulative, therefore means for different age classes are not based on the same individual trees nor on the same microsites.

Table 4.—Mean tree heights on sandy loam soils^{1/}

Species	Years in Field ^{2/}			
	One	Two	Three	Four
	Feet	Feet	Feet	Feet
<u>Pinus caribaea hondurensis</u>				
(British Honduras)	2.4	6.9	14.1	19.3
<u>P. caribaea caribaea</u> (Cuba)	1.2	3.4	8.5	13.9
<u>Spathodea campanulata</u>	2.2	3.1	10.3	8.9
<u>Eucalyptus kirtoniana</u>	3.0	5.9	9.7	6.1
<u>P. elliotii elliotii</u>	0.8	1.9	-	6.0
<u>P. taeda</u>	-	-	-	6.0
<u>Casuarina equisetifolia</u>	5.3	11.0	21.1	
<u>Hibiscus elatus</u>	4.4	8.4	15.9	
<u>Enterolobium cyclocarpum</u>	3.0	7.7	13.0	
<u>Anthocephalus cadamba</u>	4.4	7.9	12.2	
<u>Cecropia peltata</u>	2.4	4.1	11.2	
<u>Cupressus lusitanica</u>	5.0	8.3	-	-
<u>Eucalyptus</u> (Bangalore hybrid)	16.1	14.7		
<u>Khaya senegalensis</u>	4.0	6.3	-	-

^{1/} All heights were measured to completed feet.

^{2/} Growth records used are cumulative, therefore means for different age classes are not based on the same individual trees nor on the same microsites.

Growth of Trees and Stands

A spacing trial of Honduras pine was established at one additional location, and the first location of a spacing trial of cadam (Anthocephalus cadamba Miq.) was established.

Other Studies

Four short term studies were carried out in cooperation with the Syracuse University College of Forestry. Stand physiognomy and composition at a location in the tabonuco type were described; several new herbicides were tested at four levels of application; moisture balance was related to topography; and the island was mapped into ecological zones based on simple climatic data. Results of these studies of general interest are being published separately.

Plans

Complete construction of nursery facilities. Obtain both Spanish and English editions of "Trees of Puerto Rico" from the printers. Expand the arboretum, especially with native species. Complete analyses of weather data and relate weekly growth data to weather. Collect mahogany seeds and wood samples, about 20 locations per year for three years, and outplant progeny of each provenance collected.

Study nutrition of Honduras pine and cadam in the nursery. New adaptability studies will receive little effort unless early results from existing studies are modified by later developments. Spacing studies will be established of Honduras pine at five more locations and of cadam at nine. Degrees of crop tree release will be established at approximately twenty locations.

Staff

C. B. Briscoe, Project Leader
José Marrero
Herster Barres
John J. Ewel (Part time)
K. W. O. Kummé (Part time)

Publications

Briscoe, C. B.

1963. Rooting cuttings of cottonwood, willow, and sycamore.
Jour. Forestry 61:1:51-53.

Cuttings of each species were collected monthly. All species rooted every month, but March was best and June was worst. Butt-cuts rooted better than second-cuts. Willow rooted better and grew faster than cottonwood, which grew faster than sycamore.

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1963. Weather in the Luquillo mountains of Puerto Rico. Proceedings 3rd. Techn. Conf. on Hurricanes and Trop. Meteorology, Mexico, D. F.

Describes average rainfall, temperature, and wind in the Luquillo mountains, especially for the period 1959-62.

_____, and R. P. Belanger

1963. Effects in the nursery of fertilizing Afrormosia elata, Cedrela mexicana, and Eucalyptus alba. Carib. Forester 24:2 (in press).

Species tested, members of 3 families and native to 3 different continents, differed in growth rate but reacted similarly to the nutrient solutions tested.

_____, and J. Marrero

1962. La repoblación forestal en las tierras arenosas de Puerto Rico. Rev. Agricultura de Puerto Rico 49(1):129-136.

Recommends Honduras pine for general afforestation of the sandy loam soils of Puerto Rico, but suggests valuable hardwoods may be more productive on the best sites. Recommended planting techniques and plantation care are described briefly.

Clegg, A. G.

1963. Rainfall interception in a tropical forest. Carib. Forester 24:2 (in press).

Interception of the average shower (0.44 inch) varied from 23 percent at a 73 percent crown density to 70 percent at a crown density of 87 percent.

Ewel, J. J.

1963. Height growth of bigleaf mahogany. Carib. Forester 24:1:34-35.

Total height of bigleaf mahogany was found to vary with depth of the A₁ soil horizon, and with tree diameter (for trees of fixed age.)

Kumme, K. W. O.

1963. Ecological zoning in Puerto Rico, based on simple climatic data. Carib. Forester 24:2 (in press).

The island was classified into four tropical and four sub-tropical forest formations, based on temperature and rainfall.

Vozzo, J. A., and C. B. Briscoe

1963. Response of Honduras pine to various photoperiods. Carib. Forester 24:1:53-55.

Initial height growth of seedlings varied positively with length of photoperiod. By age seven weeks tallest seedlings were those which received 11 hours interrupted (8 + 3) light.

Wadsworth, F. H.

1962. Los bosques de Puerto Rico. Rev. Agricultura de Puerto Rico 49(1):78-86.

Briefly describes the natural forests of Puerto Rico.

White, H. H., Jr.

1963. Variation of stand structure correlated with altitude, in the Luquillo mountains. Carib. Forester 24:1:46-52.

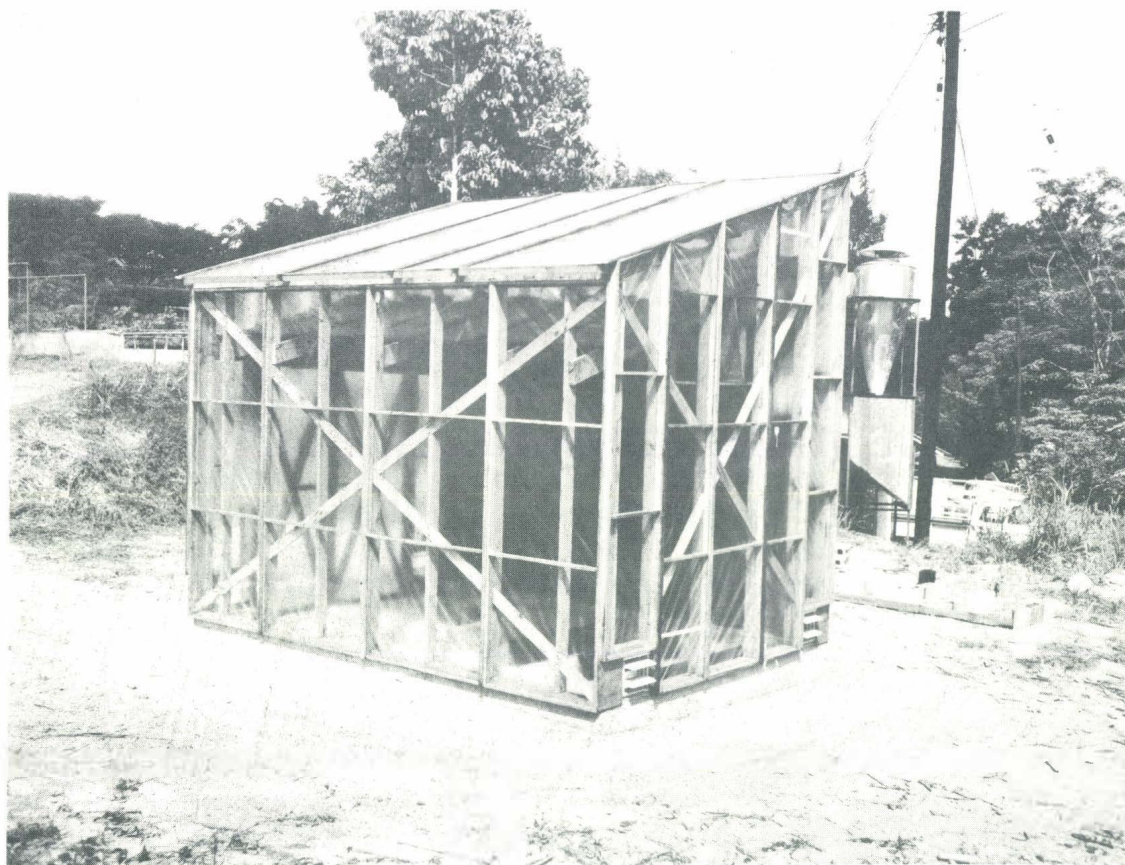
Number of trees per acre increased with elevation. Average height, diameter, and basal area per acre decreased.

FOREST PRODUCTS UTILIZATION

In the field of Forest Products Utilization the Institute is engaged in both research and technical assistance. Research during the past year produced new information in three aspects of wood utilization: seasoning, machining properties, and preservation. Technical assistance was offered to the Federal and Commonwealth governments and to processors and consumers of forest products.

Solar Drying of Mahogany

Four charges of lumber were put through the solar drier this year to supplement the data obtained from previous runs. Climatic conditions at Río Piedras are relatively uniform throughout the year, and it was found that the drying rates for boards of the same thickness are almost identical, whether processed in the summer or the winter. The time required to dry lumber from a moisture content of 25 percent to 12 percent is about 11 days for 4/4 boards, 15 days for 5/4, and 25 days for 8/4 boards.



Solar drier constructed of double wall of clear plastic material.
Río Piedras headquarters.

To reduce the moisture content of 3/4 lumber from 40 - 45 percent (green) to 20 percent the solar drier is twice as rapid as air-seasoning (20 days as compared to 40 days). Solar drying 4/4 boards through the same moisture content range requires only about 1/3 as much time as air-seasoning (6 days and 16 days respectively). Seasoning of this lumber to a moisture content of 15 percent (equilibrium moisture content for the San Juan area) would require only a few additional days in the solar drier, but at least several more months in the air-seasoning piles.

For imported mahogany sufficient information is now available to establish time schedules in the solar drier, which eliminates the need, in a commercial operation, for costly temperature and humidity recording devices and the time-consuming use of sample boards.

With the use of an appropriate time schedule, moisture content variation between boards or within boards can be held to ± 2 or 3 percent, which is comparable to that obtainable with a dry kiln. However, in most of the runs casehardening was severe, and though this defect may be of little concern to some wood processors, there are products that can be more effectively manufactured if this degrade is absent. With mist sprayers installed in the solar drier, it was found that casehardening can be removed after 1 or 2 days of conditioning (maximum temperature 130°F). Though relief of casehardening is not as rapid as in a dry kiln, the mist sprayers are a low-cost installation, in keeping with the moderate investment required for a solar drier.

Machining Properties of Local-grown Mahogany

Bigleaf mahogany (Swietenia macrophylla) is readily established on forest sites in Puerto Rico and the Virgin Islands, but there is some concern as to whether or not the more rapid-grown locally planted trees yield wood that has machining and other physical properties comparable to the fine characteristics of this timber now procured from native sites in México, Central, and South America.

Machining studies of this species from one local site and three foreign sources have been completed and the data are now being evaluated. Shaping quality has been selected as the most critical characteristic. The relationship, if any, between this property and position within the trees, growth rate, specific gravity, anatomy, etc. is being studied.

The determination of variability of these properties between sites in Puerto Rico and the Virgin Islands has also been started. The results from these evaluations should offer a guide to planting programs and indicate what silvicultural manipulations are required to produce optimum quality cabinet wood.



Wood Laboratory and Shop reconstructed in 1963 at headquarters of the Institute, Río Piedras.

Wood Preservation

Fence posts in the four service test plots were again inspected to determine the effectiveness of creosote, pentachlorophenol, carbolineum, and double-diffusion salts as preservatives applied by three nonpressure techniques: cold-soaking, hot-and-cold bath, and double diffusion. Seventy-two tree species and one bamboo received one or more treatments and, though most of the posts have been in service less than five years, there are several trends from which tentative conclusions may now be drawn. These are:

1. Whether established in coastal or mountain areas, untreated control posts have an average service life of only 1.5 years.
2. Though termite attack may be severe locally, most of the post failures are due to the activity of decay fungi.

3. Treated posts at the several high elevation plots (1,000 to 3,000 feet) have longer service life than matched material placed in the low-land plot (100 feet above sea level).
4. Posts laid horizontally in a cold-soak treatment for 5 days in 5 percent pentachlorophenol have an average service life of 6 years, but those held in the treating tank 5 days in a vertical position butt down in a 10 percent solution are clearly more durable, having a predicted service life of 10 to 20 years.
5. Posts treated by the hot-and-cold bath method using either pentachlorophenol or creosote, have to date less than 5 percent failures and average service life cannot be predicted. However, it should be noted that in an earlier study eucalyptus (E. robusta) and mesa (Micropholis chrysophylloides) posts treated with carbolineum applied by the same method have no failures after more than 13 years of service.
6. Of 1,882 posts treated by double diffusion, using two methods and chemical combinations, 90 percent, regardless of technique, are still serviceable after 3.5 years in the ground. Most of the failures are in those posts treated by the barrel method where there is little or no chemical absorption in the tops.

A supplementary study is now under way to develop hot-and-cold bath schedules for mixed hardwoods with a minimum heat treatment to make this process more attractive for commercial application.

Other Studies

Several studies were made in cooperation with Syracuse University, using students from a summer session in tropical forestry. These were: (1) an attempt to relate growth ring counts with the known ages of mahogany and teak cultivated in Puerto Rico; (2) measurement of the variation of specific gravity, moisture content, and shrinkage within a single stem of cadam (Anthocephalus cadamba) and an evaluation of the seasoning characteristics of this timber; (3) the treatability of fence posts of 10 local species by an empty-cell process using a 5 percent solution of pentachlorophenol in diesel oil; (4) a comparison of air-seasoning and solar drying of 4/4 mahogany; (5) the effect of polyethylene glycol 1000 on the seasoning degrade of bamboo (Bambusa vulgaris).

Some of these studies were exploratory and results will be used to plan future investigations. Most of the data will be included in reports to be published by the Institute.

Technical Assistance

The first commercial hot-and-cold bath treating plant was promoted. The location is southeast of the Luquillo mountains near Naguabo. Four

acres are available. The Institute is assisting the entrepreneur in the installation of the equipment and will conduct the tests necessary to assure reliable results at a minimum of cost.

The operators of sawmills located at Corozal and Villalba have been advised regarding installation, maintenance, layout, and methods of operation. Proper seasoning practices were also described for the owners. About 60,000 board feet were cut last year by the Corozal sawmill. Caoba (Swietenia macrophylla), capá prieto (Cordia alliodora), laurel prieto (Nectandra membranacea), guaraguao (Guarea trichilioides), and laurel sabino (Magnolia splendens) were the main species used. The sawmill at Villalba was in the process of installation at the end of the year. This mill is to cut cedro hembra (Cedrela odorata), capá prieto (Cordia alliodora), guaraguao (Guarea trichilioides), laurel sabino (Magnolia splendens), and moca (Andira inermis).

Furniture and millwork plants promoted by the Puerto Rico Industrial Development Company were advised regarding air seasoning practices, and methods and procedures of manufacturing.

The prospect of a novelty industry based upon small lots of unusual local timbers, particularly for the tourist trade led to the acquisition of a small carving machine now installed and ready for testing. Assistance on the selection of high quality local woods and the use of polyethylene glycol for sculpture work on green wood was provided to the University of Puerto Rico. In return the University will provide designs appropriate for the carving machine.

Two demonstrations of preservative treatment of fence posts were conducted in cooperation with Soil Conservation Service and Agricultural Extension Service with about 50 farmers in attendance.

Review of the Federal Housing Administration Minimum Property Standards for living units led to recommendations for the preservative treatment of nonstructural wood components. These recommendations were sent to the Chief Underwriter for consideration.

In the Virgin Islands technical assistance was offered to the Virgin Islands Corporation and to woodworkers in the fields of sawmill operation and wood preservation.

Plans

Complete tests of machining properties of locally grown mahogany. Relationships, if any, with provenance, site, growth rate, specific gravity, and other factors will be determined as a basis for predicting wood quality in the forest.

Develop the most practical commercial testing schedules for non-pressure preservative treatment of the more common local species of fence posts. Continue observations on service tests in progress.

Determine the suitability of a number of local woods for machine carving and develop techniques and designs attractive to this potential industry.

Staff

M. Chudnoff, Project Leader, appointed May 31, 1963
Edwin D. Maldonado

Publications

- Briscoe, C. B., J. R. Harris, and D. Wykoff
1963. Variation of specific gravity in plantation-grown trees of bigleaf mahogany. Carib. Forester 24:2 (in press).
- Maldonado, E. D.
1962. Durabilidad de postes tratados para su finca. Rev. Agricultura de Puerto Rico. 49(1):165-168.

APPLIED TROPICAL FORESTRY

As reorganized during the year, this project includes pilot scale timber management in the Luquillo and Estate Thomas Experimental Forests; technical forestry assistance to local governments and landowners in Puerto Rico and the Virgin Islands and to wood processors in the Virgin Islands; and forestry training for foreign students.

The Luquillo Experimental Forest

The Luquillo Experimental Forest, a 28,000-acre area in the eastern mountains of Puerto Rico, is serving both as an area for experiments in timber management and as a locale for the demonstration of multiple-use public forest administration.

Timber Management

Within a 7,000-acre timber production area not yet dedicated to comparative experiments, a general intensification of management continued. Of the 44 compartments in this forest, 40 were subjected to a reconnaissance to make possible recompartmentation on a basis of greater uniformity of site and stand conditions. The result was an increase to nearly 100 compartments. Each new compartment was diagnosed for silvicultural treatment, distinguishing those in which the existing stands justify management from those which are poor and need to be replaced. Following this segregation, the forest in two compartments, totaling 85 acres, was replaced by plantations of pine and mahogany. Some 800 acres of good quality forests, including old plantations, were released by treatment with poison. Crop trees, up to 100 per acre, were marked and tallied in order to simplify and to systematize future silvicultural operations.

Forest Recreation

The Luquillo Forest is rapidly increasing in popularity as an area for outdoor recreation. The La Mina Recreational Area, the center of recreational activities in the forest, was host to more than 318,000 visitors during the year, an increase of 15 percent over the previous year. Eight scenic roadside vistas were opened, a new picnic area with an annual capacity of 10,000 was constructed, and seven miles of recreation trails were reconstructed, including a one-mile self-guided nature trail nearly ready for use.

A Visitor Information officer completed his first year of duty in the La Mina area, providing for the first time direct communication between the Institute and the general public at this site. A beginning has thus been made utilizing the educational potentialities of this interesting and intensively used area.

Other Forest Uses

The Luquillo Forest is in demand for a number of other uses. Growing in importance among these uses is research allied to that of the Institute. A Biological Station of the University of Puerto Rico has served as a center for specialized studies of the fauna and flora by both resident and visiting scientists. The Nuclear Center of the University began during the past year a long-range study of the effects of gamma radiation on the forest. Formal experiments on the effects of herbicides and growth inhibitors were begun by the Agricultural Research Service of the Department of Agriculture and by the Battelle Foundation. A new camp of the Puerto Rico Department of Education to provide work for young men who have left school was established within the Forest. Additional radio communications facilities on the peaks bring the total number of use permits to 150.

Soil stabilization problems along the East Peak Road within the Luquillo Forest led to the development of a successful revegetation technique with molasses grass (Melinis minutifolia), using a mixture of seed, soil, and fertilizer.

About 50 percent of the \$750,000 Catalina-Sabana road across the Maneyes valley on the north slopes of the Luquillo Forest was completed. The remainder is being contracted.

The forest along the main road through the Luquillo Experimental Forest to the La Mina Recreational Area was improved and vistas were opened to provide greater educational value of this popular area. Signing of all points of interest is being planned.

The Estate Thomas Experimental Forest

This Forest, covering 147 acres on St. Croix, Virgin Islands, was formally acquired for use by the Institute for research and demonstration.

Surveys were completed and the boundaries were monumented. The tract contains 80 acres of natural forest of small-leaf mahogany (Swietenia mahagoni), all of which has received silvicultural treatment, and within which growth studies are in progress. Also included is a 20-acre area of teak plantations now averaging 5 years of age. These also have been treated and are under measurement. Research within this area is directed toward the relationship of tree size, spacing, and diameter growth.

State and Private Forestry in Puerto Rico

Liaison with the Division of Forests of the Puerto Rico Department of Agriculture involved sharing of costs in the construction of a new nursery for the production of planting stock for farm forestry, sharing of costs of stock production and distribution to farmers, and for technical assistance to landowners. The new nursery is expected to make possible for the first time mechanized operations and corresponding reductions in cost. Superior seed source areas were located for teak and mahogany, for the use of the Division of Forests. Nursery production and distribution during the year totaled 1,267,000 trees. Technical assistance was given by this program in response to 2,849 requests concerning forestry on 1,146 acres of privately owned land.

Technical assistance was provided to the Division of Forests in the administration and management of their public forest lands. This concerned planting, plantation care, inventory, management planning, and recreation planning.

State and Private Forestry in the Virgin Islands

The forestry program in the Virgin Islands, formerly sponsored by the Virgin Islands Corporation, completed in 1963 its first year as primarily a Forest Service technical assistance activity.

The forest nursery in St. Croix, together with the inventory of nursery stock, was accepted as a financial obligation of the Virgin Islands Government, to be operated under Forest Service technical supervision. A total of 13,300 mahoganies were carried over from the previous year because of drought during the planting season. About 8,600 more were produced during the year. Plantings required 13,700, leaving a carry-over of about 8,200 at the end of the year. Plantings were made on 6 estates in St. Croix, and more than 1,000 trees were sent to each of the other main islands, St. Thomas and St. John. The total area planted was 22.6 acres. Roadside improvement in St. Croix included the planting of 200 mahoganies and pruning of trees along 3 miles of road.



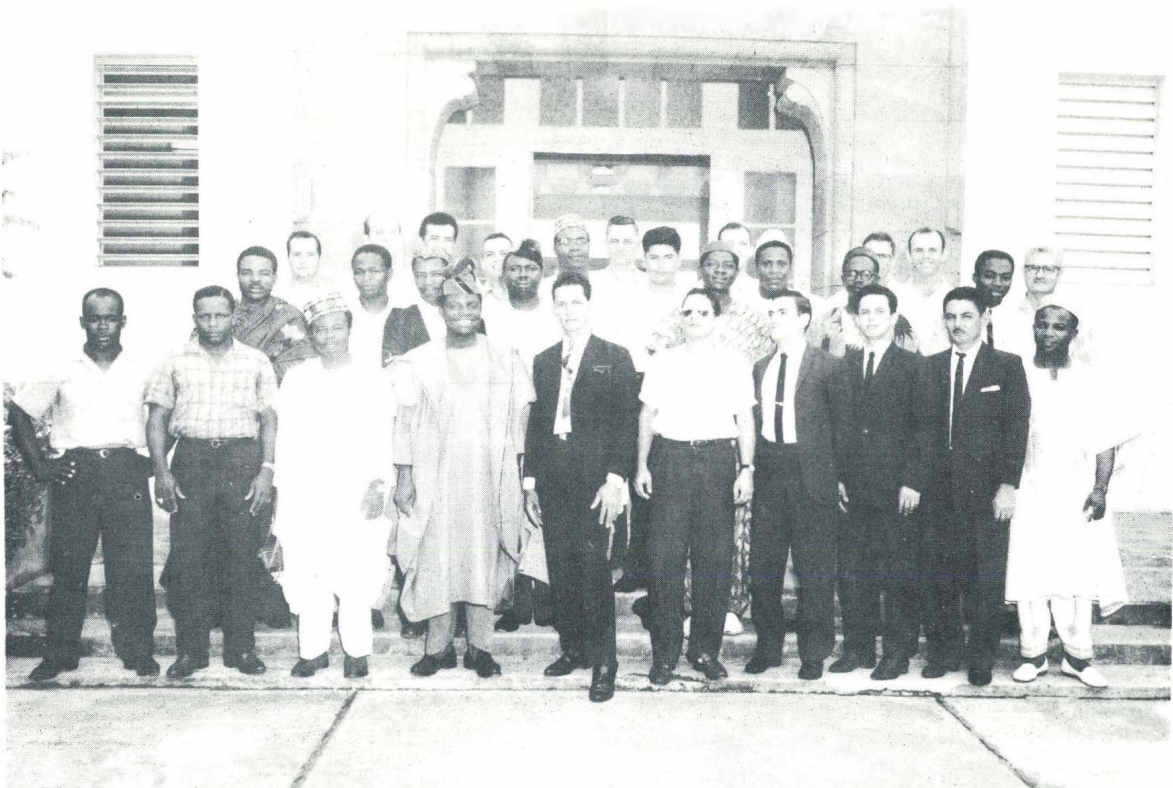
Broadleaf mahogany (Swietenia macrophylla) four years old. Underplanted on a private farm beneath native forest and subsequently released. St. Croix, Virgin Islands.

To date a total of 100,000 mahoganies and 37,700 teaks have been planted at 37 different locations in the Virgin Islands since 1954. Successful plantations have resulted on 226 acres. Plantation release was carried out on 64 acres during 1963. With the exception of a few special research plantings all of this reforestation is financed directly by the landowner.

The Sion Farm sawmill and post treating plant owned by the Virgin Islands Corporation were operated intermittently under the technical supervision of the Forest Service. The mill cut 3,650 board feet of lumber, mostly mahogany. The plant treated some 4,000 posts. All of these products not needed by the program were sold by the end of the year. The posts are now well distributed for demonstration purposes throughout St. Croix.

Forestry Training

The Tenth Tropical Forestry Short Course was held from June 12 to September 6. Twenty-three participants attended, from Bolivia, Dominican Republic, Jamaica, Liberia, Nigeria, Panama, Sierra Leone, Togo, and Cambodia.



Students of the Tenth Tropical Forestry Short Course.

The second Summer Session in Tropical Forestry was held cooperatively with the College of Forestry of State University of New York at Syracuse. Sixteen graduate students participated. Course work included 11 research projects undertaken with the general supervision of the Institute. Reports of several of these are cited herein. One not reported located select seed-production areas for mahogany and teak for use by farm forestry programs.

In addition to these formal courses the Institute was host to 22 other students and visitors from nine countries.

Fourteen Peace Corps candidates for forestry assignments in the Dominican Republic were provided two weeks of intensive training and field experiences as final preparation before their departure.

Subject matter covered by the training was very broad, including seed collection, nursery practice, reforestation, dendrology, ecology, silviculture management, utilization, administration, land use, and national forest policy and legislation.

Plans

In the Luquillo Forest the revision of multiple use and timber management plans are proposed for the near future. Intensification of the betterment work in the most promising stands is to follow promptly thereafter. It is hoped that much of the roundwood yield from these operations can be processed by the new treating plant. Continued expansion of recreation facilities is anticipated. Particularly important are roads, trails, signs, and new picnic facilities.

At the Estate Thomas a systematic improvement cutting in all of the mahogany stands is to be completed soon as a prerequisite for meaningful studies of growth on well-spaced trees. Systematic coverage of the south portion of the forest is proposed first.

State and private forestry plans for Puerto Rico include completion of the new nursery, the development of less expensive techniques to produce pine stock, and further technical training to farm foresters.

In the Virgin Islands an inventory of standing mahogany timber is contemplated as a basis for realistic planning for industrial development. Also in prospect is a single large-scale reforestation proposal of one landowner which will provide good information on costs of operation.

Staff

Joseph W. Sposta, Project Leader to September 1, 1963
Lawrence W. Hill, Project Leader from September 15 to
December 31, 1963
Robert W. Nobles, In Charge, Virgin Islands Program
Juan E. Muñoz